

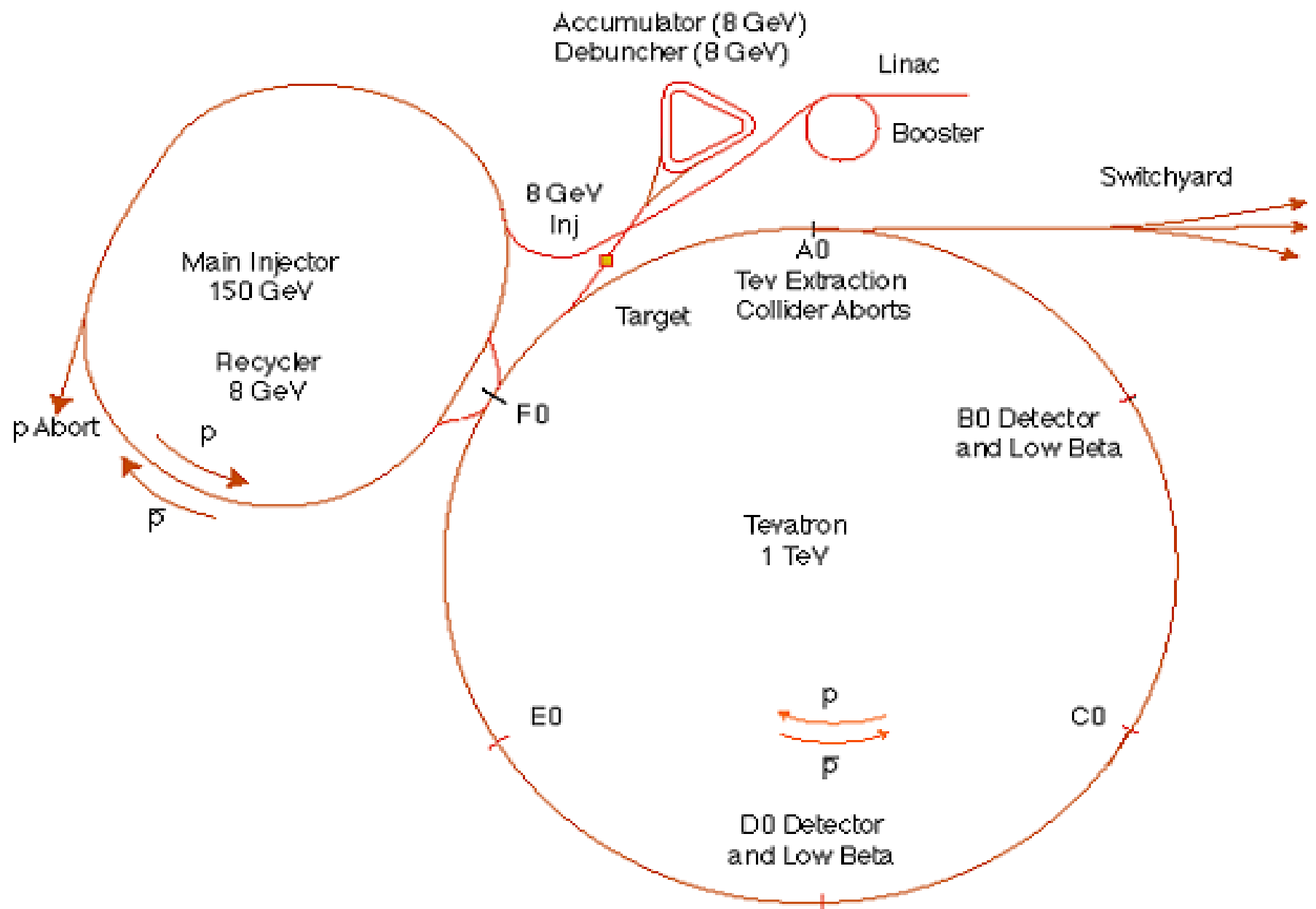


FNAL Accelerator Complex 101: What's Happening in the Machines?

Ron Moore – FNAL

- Accelerator Complex Overview
- Shot-Setup according to the MCR
- Miscellany

Fermilab Tevatron Accelerator With Main Injector



Channel 13, a.k.a “Notify”

Notify: Collider Op

12.9

current supercycle

61.0

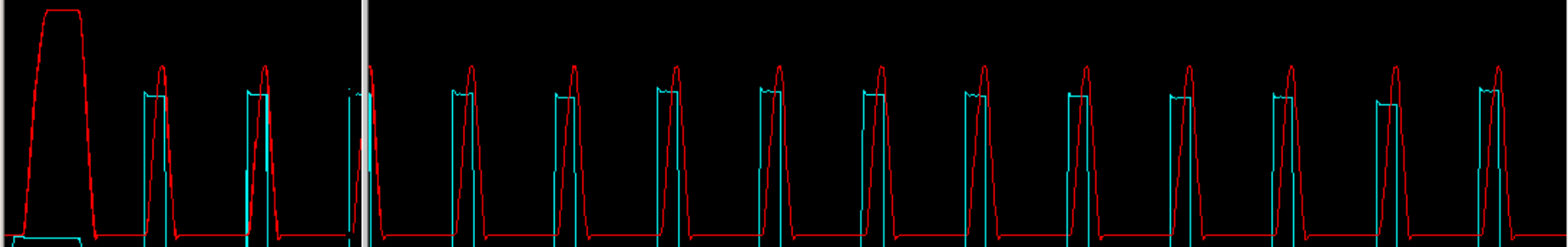
9 9 9 9 9 9 9 9 9 9 9 9 9 9

B

Store #:	2689	TevKE	979 GEV	Stack	115.38 E10	6/16/2003 10:54:18	
B0Lum	10.76 E30	TevDC	5.56 1E12	AccRt	5.97 mA/h	MIBeam	0.0 E12
D0Lum	10.18 E30	TevPR	4849 1E09	ProdEff	15.60 E-6	RRlbeam	-0.01 E11
SDur	843 MINS	TevPB	497.6 1E09	MB	2.61E16 P/hr	Temp	87.72 DEGF

15 Jun 2003
20:52:41
Returning to
Pbar Stacking

15 Jun 2003 20:55:29
Stacking. Store 2689 colliding.
MiniBooNE running.



Channel 13 with help

Notify: Collider Op

12.9

Time line + MI ramp cycles

current supercycle 61.0

9 9 9 9 9 9 9 9 9 9 9 9 9 9

B

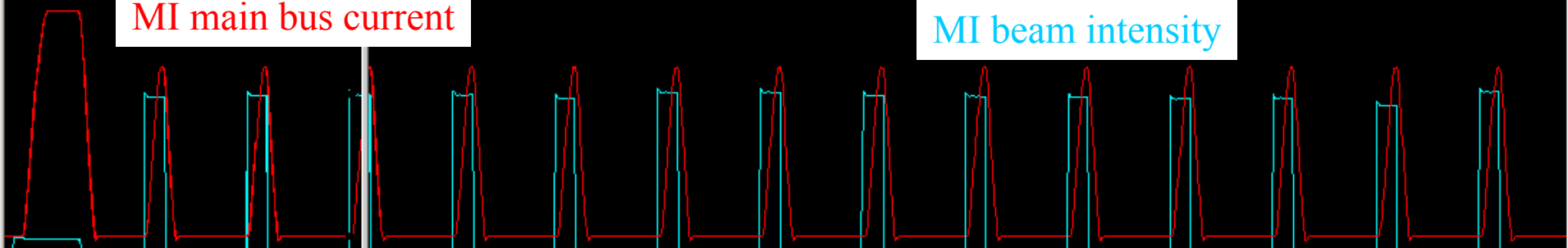
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15 Jun 2003
20:52:41
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15 Jun 2003 20:55:29
Stacking. Store 2689 colliding.
MiniBooNE running.

MI main bus current

MI beam intensity





MCR Glossary

- **Stack** = antiprotons being stored in the Accumulator
- **Store** = beam kept circulating continuously in the Tevatron; can be an HEP store (protons and pbars), or proton-only for studies/maintenance
- **Flattop** = Tev ramped to 980 GeV, **before** low β squeeze
- **Squeeze** = Focusing the beams to smaller transverse size at CDF/D0
- **Low Beta** = Tev @ 980 GeV, **after** low β squeeze
- **Initiate Collisions** = turn on electrostatic separators to make beams collide at the centers of CDF and D0
- **Scrapping** = Removal of beam “halo” (stuff far away from beam center) by moving stainless steel collimators close to beam; reduces beam losses at CDF/D0; done automatically after collisions begin
- **Cogging** = moving the (pbar) beam longitudinally desired location
- **Abort Gaps** = series of empty buckets between bunch trains to allow abort kickers to reach proper voltage to kick beam into dump blocks



Instrumentation Glossary

- **FBI** = Fast Bunch Integrator
 - Provides Tev bunch intensity measurements
- **SBD** = Sampled Bunch Display
 - Gives Tev bunch length measurements
- **TEL** = Tevatron Electron Lens
 - Device that shoots a ~few mA electron beam in the Tev beam pipe
 - Used to knock beam out of the abort gaps (reducing CDF backgrounds)
 - Intended to compensate beam-beam tune shift of pbars from protons (not yet)
- **SDA** = Shot Data Acquisition
 - Accelerator data collection/storage for each shot/store; used for offline analysis
- **QPM** = Quench Protection Monitor
- **QBS** = Quench Bypass Switch



Prior to Shot-Setup

- Experiments turn off HV after MCR calls
- Experiments call MCR to confirm they are ready
- Tev abort kickers fire driving beam into A0 dump blocks



Shot Setup Overview

- Between one store and the next:
 - Assume sufficient pbars to go again($>100\text{mA}$)
 - Time between shots:
 - $\sim 2\text{-}3$ hours if things are going well
 - Beams Division goal is 1 hour
 - Calibrations (Quiet time ?)



Shot Setup Overview

- Beginning of the next store:
 - Protons are injected first, then pbars
 - Accelerate beams to 980 GeV
 - Cogging
 - Low Beta Squeeze
 - Scraping
- Once losses are low and the beam is stable, Ramp the HV and begin taking data



Shot Setup Overview

- **Injection** – the process of transferring protons or antiprotons from the Main Injector to the Tevatron (4 bunches at a time)
- **Ramping** – the magnetic fields of the magnets are increased simultaneously, boosting proton/pbar energies from 150 GeV to 980 GeV (“flattop”)



Shot Setup Overview

- **cogging** – the process of spacing the bunches of protons or pbars in the TeVatron so that they collide at the proper points in the ring.
- **low beta squeeze** – after injecting protons and pbars into the TeVatron, a special set of quadrupoles are turned on at B0 to reduce the size of the beam and increase luminosity.
- **scrapping** – using collimators to remove the beam “halo” and reduce losses.
 - MCR will notify CDF when scrapping is complete, but you should be monitoring the ACNET variable **T:VSCRAP** too !

Channel 13 while Tev is ramping

Notify: Collider Op

24.2

current supercycle

33.6

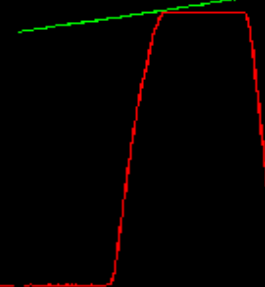
A

Store #:	2692	TevKE	664 GEV	Stack	6.98 E10	6/16/2003 14:40:19
B0Lum	0.0 E30	TevDC	8.36 1E12	AccRt	0.08 mA/h	MIBeam -0.00 E12
D0Lum	0.62 E30	TevPR	7255 1E09	ProdEff	0.0 E-6	RRlbeam 1.04 E11
SDur	917 MINS	TevPB	753.6 1E09	MB	3.16E16 P/hr	Temp 75.00 DEGF

Jun 16
2003-14:38:52.0
Ready to
Accelerate to
Flattop

Jun 16 2003-14:39:28.0
Tevatron ramping to 980 GeV.
Shot setup.
MiniBooNE running.

Tev main bus current



Data Logger Plotter

tibeam (Ctrl) 2401 points

c:fbiplng (Ctrl) 2400 points

c:fbiang (Ctrl) 2400 points

t:ering (CDF) 2393 points

c:lbseq (CDF) 2399 points

t:f49v (Mech) 160 points

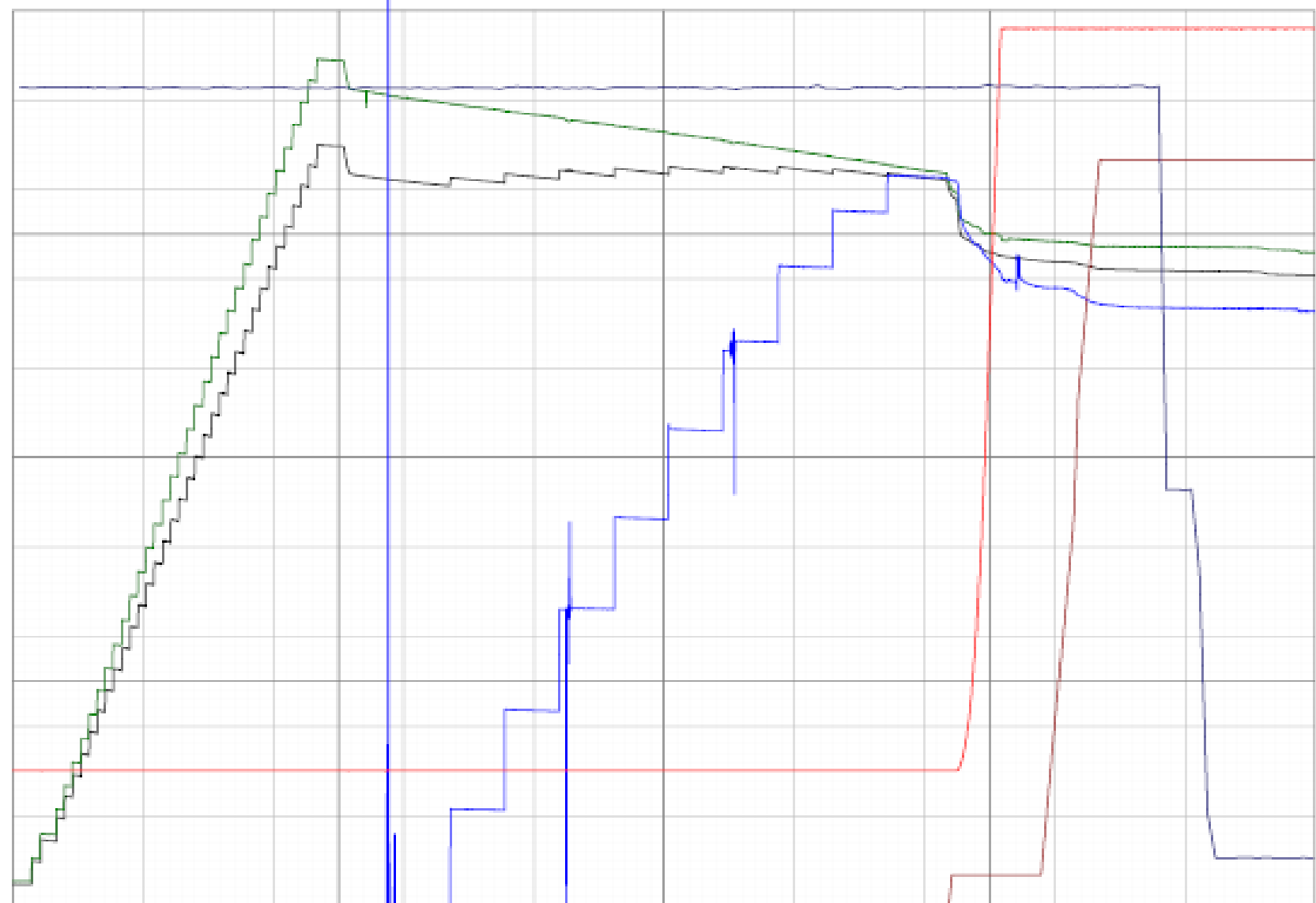
30
1000.00
12
10000
1000.00
800.00

22
750.00
9
7500
750.00
500.00

15
500.00
6
5000
500.00
200.00

8
250.00
3
2500
250.00
-100.00

0
0.00
0
0
0.00
-400.00



45:00

55:00

05:00

15:00

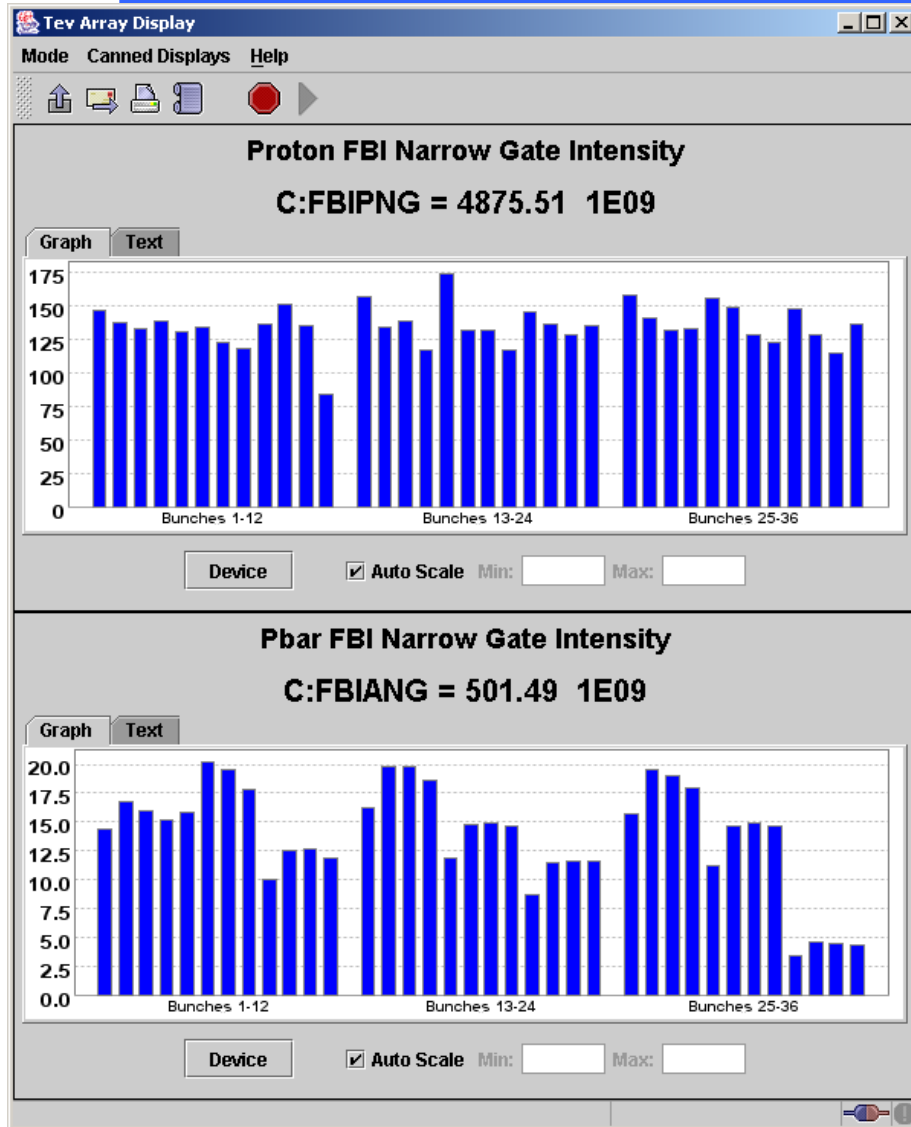
25:00

start time: 06/17/03 07:45:00 (231)

finish time: 06/17/03 08:25:00 (231)



Tev Array Display



- Shows bunch-by-bunch parameters
- Usually running on Windows machine in CDF control room??
- Useful during injection to see how many bunches are in the Tev

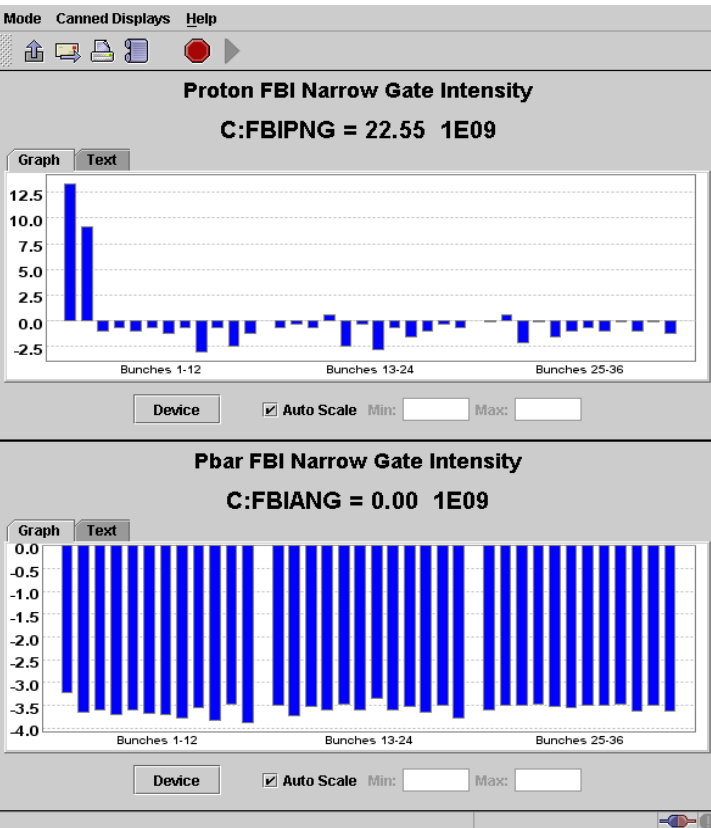


Coalesced vs Uncoalesced Beam

- Uncoalesced
 - 30 or so consecutive RF buckets filled with ~ 10 E9 protons/bunch
 - Usually used for machine tune-up, studies
 - Protons only (well, pbars can be uncoalesced if needed for some study)
- Coalesced
 - 5-7 buckets of beam merged into a single RF bucket at 150 GeV in the Main Injector
 - Protons and pbars always coalesced for HEP stores



Two Little Bunches in the Tev?



- No, the FBI ACNET devices look only at buckets that should be populated with coalesced beam for HEP store
- 2 of the 30 bunches of uncoalesced protons happen to be in the buckets used for P1 & P2